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RM-3817-NASA
SEPTEMBER 1963

OVERSEAS TELECOMMUNICATIONS TRAFFIC AND COMMODITY TRADE

Robert L. Slighton

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PREFACE

This RAND Memorandum is a product of the investigation of the economic implications of communications satellites conducted by The RAND Corporation for the National Aeronautics and Space Administration under contract number NASr-21 (01).

The present study is a brief statistical analysis of the relationship between overseas commodity trade and overseas telecommunications traffic. It is designed to provide background information for officials in NASA and other U.S. government agencies who are responsible for communication satellite R&D policy. Two closely related RAND studies are also being issued at this time: RM-3831-NASA, The Market for Overseas Telecommunications in 1970, by R. L. Slighton, and RM-3877-NASA, High-Capacity Submarine Telephone Cables: Implications for Communication Satellite Research and Development, by R. T. Nichols.

Many researchers connected with the telecommunications industry both in the United States and abroad have suggested that the growth of overseas telecommunications traffic is intimately connected with the growth of overseas trade and that the future pattern of telecommunications traffic is likely to resemble the pattern of trade. It is hoped that this study will provide some quantitative perspectives for these suggestions as well as provide a partial basis for a more fruitful discussion of the prospects for the growth of telecommunications systems than has been heretofore possible.

The author is indebted to L. L. Johnson, J. Minasian, R. T. Nichols, and G. M. Northrop of The RAND Corporation for their comments and suggestions and to the many officials of the American Telephone and Telegraph Company who provided unpublished statistical information concerning overseas telephone traffic.

SUMMARY

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Efficient R&D and system planning for new overseas telecommunications systems calls for good estimates of the future volume of the traffic likely to be carried over various links. This is especially true of satellite communication systems, which may be economic only if their potentially large channel capacity is well utilized. It is often assumed that the growth of overseas telecommunications traffic has been (and will be) intimately connected with the growth of overseas trade. The purpose of this Memorandum is to explore this assumption statistically by looking at the record since 1950. The method is that of regression analysis which explores the relationship between telecommunications traffic on the one hand and trade as an "explanatory" variable on the other.

Section I provides a brief introduction to the nature of the problem. Section II describes the existing geographical distribution of commodity trade and overseas telecommunications traffic and shows that they are by no means closely related. Section III uses regression analysis to study the relationship between long-run (1950-1960) changes in country-to-country trade and telecommunications traffic. In a similar way Section IV analyzes this relationship for short-run changes, that is, year by year. AUTHOR

LONG-RUN GROWTH OF TRADE AND TELECOMMUNICATIONS TRAFFIC

The analysis presented in Section III does not support the view that trade expansion is a principal "cause" of the long-run increase of overseas telephone traffic. First, none of the estimates of the quantitative relationship between changes in trade and changes in telephone traffic obtained through regression analysis is statistically significant (at the 95 per cent confidence level). Second, even if the standard errors of estimate of this relationship are ignored, changes in trade explain only a relatively small proportion of the changes in telephone traffic. For example, the increase in

trade between the United States and Europe accounts for only about one-fifth of the increase of telephone traffic on this route. The remaining portion is presumably accounted for by such factors as the growth of tourism, increases in income, the growth of U.S. politico-military commitments abroad, and (perhaps most important) the need for rapid communications brought about by faster transportation.

For telegraph traffic, trade is apparently a much more satisfactory explanatory variable. The estimates of the relationship between changes in trade and changes in telegraph traffic are not only statistically significant (at the 95 per cent confidence levels) but account for a relatively large proportion of the total changes in telegraph traffic. For example, it appears that, between the United States and Europe, the growth of commodity trade accounted for about five-sixths of the growth of telegraph traffic over the period 1950-1960.

SHORT-RUN CHANGES IN TRADE AND TELECOMMUNICATIONS TRAFFIC

The volume of overseas trade is rather unstable in the short run, year-to-year changes of 15 to 20 per cent being not uncommon. According to the regression analysis, these changes account for a large part of the year-to-year changes in overseas traffic, both telephone and telegraph. An important consequence of this is that, if long-run telecommunications traffic projections are based on extrapolations of the rate of traffic growth over a base period, it is essential that the data for the base period should be adjusted for the trade cycle.

CONTENTS

LIST OF TABLES

I. INTRODUCTION AND GENERAL CONCLUSIONS

THE NATURE OF THE PROBLEM

The question of the size and configuration of the future market for overseas telecommunications is one of the most important problems that the systems planner in the field of communications satellites must attempt to answer. Yet relatively little systematic analysis of this problem has been undertaken. Previous studies tend to fall into one of three categories: market forecasts that are simple extrapolations of past rates of growth of overseas telecommunications volume; forecasts based on an estimate of the relationship between the size of domestic telecommunications systems and the demand for overseas telecommunications services; and forecasts based on the assumption that the demand for overseas telecommunications services is closely related to the volume of overseas commodity trade. The usefulness of projections derived from models of the last type and the nature of the relationship between the demand for telecommunications services and the volume of commodity trade is the subject to be discussed here. The point should be stressed that this Memorandum is only an investigation into the relationship between telecommunications and trade -- not an attempt to explain the history of telecommunications traffic completely. The results of a somewhat larger effort to synthesize what information we have about the growth of demand for overseas telecommunications into a market forecast for 1970 will be presented in a companion Memorandum, The Market for Overseas Telecommunications in 1970, RM-3831-NASA, September 1963.

There are three substantive sections to this report. Section II consists of a brief description of the present geographical distributions of overseas commodity trade and the various telecommunications services. Sections III and IV contain the results of a statistical analysis of the available data on changes through time in the volume of telecommunications traffic and commodity trade:

Section III is concerned with the relationship between changes in telecommunications and changes in trade in the long run; Section IV deals with this relationship in the short run. The analysis addresses the following question: "If we are given new information about the future course of overseas trade, what new information do we have about the market for overseas telecommunications?"

The argument that the volume of telecommunications can be "explained" and hence predicted largely in terms of the volume of trade does not necessarily depend on the premise that the great bulk of telecommunications arises directly from the physical movement of commodities. The trade model would be useful if the volume of trade were a reliable index of the extent of commercial relations in the larger sense -- including financial transactions and relationships deriving from ownership of foreign assets -- and if the volume of telecommunications that do not have a commercial origin were either small or strongly collinear with the volume of telecommunications arising in the commercial sector. Given these considerations the trade hypothesis would not seem to apply to traffic to points where tourism is of much greater importance than trade (that is, most of the Caribbean islands) or to points such as the oil-exporting countries whose primary trade relationship with the United States is through the export of one commodity by a small number of firms. In the latter case the volume of commodity trade is not likely to be a good index of the extent of all commercial relations, and the volume of telecommunications likely to arise out of the bulk movement of the primary commodity is likely to be negligible.

The most serious barrier to a meaningful estimation of the effect of changes in trade on the demand for telecommunications services derives from the fact that the variable of interest is the volume of telecommunications which a future system might be asked to accommodate, while the data with which the analyst must work are records of the volume of telecommunications actually accommodated. The difference is, of course, that the volume of telecommunications actually accommodated is a joint function of supply and demand. If the influence of supply considerations were stable over time and of the same importance for each of the various overseas links, there would be little difficulty in drawing inferences about demand from analysis of its surrogate, traffic. This is not the case, however. The adequacy of the physical facilities for transmission of overseas telecommunications relative to the demand for such services has varied widely from link to link and has varied widely on particular links from year to year.

Even the notion of excess demand for telecommunications service is not susceptible to simple definition. The demand for telecommunications is not a simple function of price but a complex function of price and quality. By quality is meant not just physical quality of circuit but also the average length of time the customer waits for service. The market for overseas telephone service is maintained in continuous equilibrium not through price adjustment but through changes in consumer response to continuous changes in the quality of service made possible by the physical facilities in existence. Telecommunications services are in excess demand or excess supply only in the sense that there is a given excess demand or supply of services of a particular quality. Most previous investigations into the probable size of the future telecommunications market have, surprisingly, failed to take into account the sensitivity of demand to changes in the quality of service.

For this reason it would be difficult to obtain quantitative estimates of the nature of the relationship between trade and telecommunications that could be considered very reliable even if a large sample of observations as to past behavior were available. Unfortunately, the data that seem most relevant to the near future cover a fairly narrow time span -- 1950 to 1961 -- and this only for traffic involving the United States. The only detailed information available as to the distribution and size of telephone traffic involving foreign points exclusively is a traffic summary for the year 1960 compiled by AT&T; and despite the care taken in its preparation many of the estimates in this summary are necessarily subject to wide errors.

It should also be pointed out that statements concerning the quantitative relationship between changes in telecommunication volume and changes in trade have no causal implications. The fact that the volume of telecommunications is the "dependent" variable and the volume of trade the "independent" variable in this study does not mean that improvements in the quality of telecommunications services cannot have an effect on the volume of trade. Indeed, this is one of the problems in forecasting the telecommunications market on the basis of trade projections. Given the relative scarcity of data there appears to be no way of identifying the relative importance of the two causal processes: (a) increases in the volume of telecommunications induced by exogenous increases in the volume of trade, and (b) increases in the volume of telecommunications induced by changes in trade that are themselves induced by increases in the quality of communications. It is assumed, but not proved, that most of the changes in trade in the period studied were unrelated to changes in the quality of communications.

GENERAL CONCLUSIONS

The following section suggests strongly that the future demand for telecommunications services will depend upon many factors besides the volume of commodity trade. If the only information we possessed about the determinants of the volume of overseas telecommunications were estimates of the future volume of trade, we would not be in the position of being able to estimate the future size of the telecommunications market with much assurance even if our information on trade were perfect. In actuality, we possess very little information of any substance as to the likely volume of overseas trade in the future. Most estimates of future trade are derived from simple extrapolations of past long-term rates of growth of trade. If changes in the volume of telecommunications are viewed as the sum of an autonomous change that is proportional to current traffic and a change that is proportional to the change in trade, forecasts of the volume of overseas telecommunications based on trade forecasts will be essentially the same as forecasts that are simple extrapolations of telecommunications traffic at past average rates of growth. In other words, forecasts based on a trade model are likely to be merely disguised versions of forecasts based on a naive model -- a model that says that the rate of growth of telecommunications in the future will be the same as the rate of growth of telecommunications in the past.

Even though it appears that there is little profit in attempting to forecast the future demand for telecommunications services solely on the basis of a model in which time and trade are the only independent variables, the results of analysis of the relationship between trade and telecommunications are of some use to the forecaster. Most important, such analysis points up the necessity for adjusting the rate of growth of telecommunications during the time period used as a basis for extrapolation for whatever differences from long-term expected trade experience were characteristic of that period. This is of particular importance if the time period that is judged to be the most satisfactory basis for extrapolation in most respects is not a complete period from the point of view of the trade cycle. Analysis of trade-telecommunications relationships is also of value insofar as it is desired to explore the possible implications for the growth of telecommunications of particular autonomous changes in trade patterns. If it is presumed that future tariff reductions or shifts in resources implied by such autonomous changes as the establishment of the Common Market are likely to lead to a given increase in the volume of trade, the coefficients obtained through regression analysis provide a rough basis for predicting the effect of these changes in trade on the size and distribution of the market for telecommunications services.

Our understanding of the quantitative importance of the many factors determining the demand for overseas telecommunications is highly unsatisfactory. The major limitation is the fact that many of these factors cannot be measured directly but only in terms of their effect on the dependent variable -- the volume of telecommunications. For example, the shrinking of the time significance of distance -- an important element behind the secular or autonomous element of telecommunications -- is such a factor. The importance of language differences is another important determinant of demand which is recognizable but which is not susceptible to direct measurement. Such factors are sufficiently important (in determining both the distribution of demand at any moment of time and its rate of growth through time) to preclude construction of a forecasting model that is not in large measure a "naive" model. The basic argument against "naive" models -- models which assume that future changes are directly proportional to past changes -- is that all changes in the dependent variable are thus autonomous (given but unexplained) changes. This defect is not avoided if the growth of telecommunications is explained in terms of a model that relates changes in the demand for telecommunications to changes in trade. The quantitative relationship between trade and telecommunications is apparently such that the predictive accuracy of a trade model is basically dependent on the accuracy with which autonomous changes are estimated.

II. A COMPARISON OF THE PRESENT GEOGRAPHICAL DISTRIBUTIONS OF OVERSEAS TRADE AND TELECOMMUNICATIONS

There is no difficulty in recognizing that the pattern of overseas or interregional commodity trade is very different from the pattern of overseas telecommunications. The only difficulty is in choosing a method of describing these differences and in estimating the importance of the various factors that are responsible for them. One basis of comparison is the relative share of the total interregional traffic in commodities and telecommunications services attributable to each region. Such figures for one set of regional classifications are summarized in Table 1. The data from which this table was calculated represent only a portion of total overseas or international telecommunications traffic and trade. All intraregional traffic is excluded. Traffic between the United States and Puerto Rico and traffic between the continental United States and Hawaii is excluded because of the unavailability of data on commodity trade over these routes that are comparable with the data on international commodity trade. Telecommunications traffic between Europe and North Africa was omitted because of the unreliability of estimates of the volume of telephone messages between France and Algeria. The trade totals refer of course to the same set of links as do the data on telecommunications services.

The most striking feature of the distribution of Table 1 is the relatively large involvement of the United States in the total world telecommunications market. For each mode of telecommunications the share of the United States in the total world market greatly exceeds the United States share of commodity trade. This difference is greatest for message telephone service, the relatively most expensive of these services and the service that has by far the largest requirement for bandwidth. With relatively few exceptions the shares of total telecommunications traffic of those regions that are characterized by relatively low income per capita are markedly less than their share of total trade. A factor to be considered in

Table 1

DISTRIBUTIONS BY AREA OF OVERSEAS TRAFFIC[a] IN COMMODITIES, MESSAGE TELEPHONE, MESSAGE TELEGRAPH, AND TELEPRINTER EXCHANGE SERVICE (TELEX)

(Total Incoming and Outgoing Traffic = 200 per cent)

	Type of Traffic			
Area	Commodity Trade (1960)	Message Telephone (1960)	Message Telegraph (1958)	Telex (1962)
United States	37	60	50	57
North America	47	71	58	63
Europe	64	66	71	64
South America	17	13	18	17
South Africa	4	3	4	2
North and Central Africa	12	6	10	7
Middle East	12	3	7	2
South Asia	16	9	9	3
Japan	12	9	10	30
East Asia, other than Japan	8	11	5	6
Oceania	8	9	8	6
	200	200	200	200

Notes:

[a] Overseas traffic is defined so as to exclude traffic between the United States and Alaska, Hawaii, the Caribbean, and Bermuda, and traffic between France and Algeria. The percentage figures for each area total to 200 per cent because there is no distinction made between initiation and termination of traffic.

Sources:

Commodity Trade: United Nations, Yearbook of International Trade Statistics, 1960, New York: United Nations, 1962;
Message Telephone Service: Estimates provided privately by the American Telephone and Telegraph Company;
Message Telegraph Service: International Telecommunications Union, General Telegraph Statistics, 1958, Geneva: ITU, 1959;
Telex Service: International Telecommunications Union, Development of the International Telex Service, Geneva: ITU, 1962.

explaining the relatively high share of total telephone traffic involving the East Asian nations other than Japan is probably the consequence of the presence of United States military personnel in Okinawa, Korea, and Taiwan. The very large fraction of telex traffic that originates or terminates in Japan is likely to be in large part the consequence of language problems which restrict the uses of voice communication.

The magnitude of the differences between the distributions of trade and telecommunications that is revealed by comparison of regional shares depends of course on the extent to which the data have been aggregated. The patterns of trade and telecommunications appear to be much less closely related than is indicated in Table 1 if ratios of telecommunications volume to trade volume are compared for individual interregional links. Ratios of the number of telephone messages to the volume of trade for the more important interregional links are reported in Table 2. The number of revenue minutes would be a more appropriate numerator than the number of messages for these comparisons, but this information is not available for all links. The distortion brought about by this substitution is not likely to be large, however.

There is no simple answer to the question of why the ratio of the volume of telecommunications to the volume of trade over one interregional link should be as much as twelve times that of another major link. Part of the answer lies in differences in the adequacy of the telecommunications capacity supplied relative to the capacity required to accommodate existing demand at a given standard of quality of service. The fact that the ratio of telecommunications to trade is higher for the link between North America and Europe than for any other link is in large part the result of the introduction of the transatlantic cables. The bulk of the transatlantic traffic is carried over cable circuits while virtually all of the traffic over other routes is carried over high-frequency radiotelephone circuits. The average quality of signal over HF radio circuits is generally inferior to that of cable circuits and there

Table 2

RATIOS OF VOLUME OF INTERREGIONAL TELEPHONE MESSAGES TO VALUE OF INTERREGIONAL TRADE FOR SELECTED INTERREGIONAL LINKS

Link	Number of Telephone Messages per Million of U.S. Dollars of Trade in 1960
North America-Europe	84.4
North America-South and Central America	37.5
North America-South and East Asia	25.0
North America-Oceania	44.4
North America-Africa	6.7
Europe-Oceania	15.2
Europe-Middle East and South Asia	12.4
Europe-East Asia	6.9
Europe-Africa	24.7
Europe-South America	7.1
Oceania-South and East Asia	13.6
Japan-South and East Asia	43.1

Sources:

Interregional Trade: United Nations, Yearbook of International Trade Statistics, 1960, New York: United Nations, 1962.

Interregional Telephone Message Volume: Estimates provided privately by the American Telephone and Telegraph Company.

is good reason to suspect a substantial consumer response to this quality differential. Furthermore, the relative availability of voice channels is such that the average waiting period between the time of initiation and time of completion of calls to points outside Europe is considerably in excess of the average waiting time on calls between the United States and those European countries linked to the United States by cable. The importance of such supply considerations can be judged in part by the relative changes in the volume of telephone messages and trade over various routes during the period of cable construction, 1955-1960. In 1960 the ratio of telephone message volume to trade volume across the North Atlantic was over twice as high as the same ratio for the routes between the United States and Latin America. In 1955, the last year during which transatlantic telephone traffic was carried exclusively over HF radio circuits, the telephone message/trade volume ratios on the North America-Europe and North America-Latin America routes were approximately equal. The state of development of local telecommunications is a further complicating influence. It is often quite difficult to tell whether or not supply bottlenecks on overseas links are domestic or international in origin. Increases in the number of available voice channels on overseas routes will not lead to a significant reduction of waiting time if domestic trunks are overcrowded.

There appears to be no simple way of evaluating the relative importance of supply and demand factors in explaining the observed differences in the distributions of trade and telecommunications. That a large part of the difference must be ascribed to demand factors does seem clear, however. Differences in the importance of telecommunications demand arising from tourism and politico-military commitments, differences in demand arising from differences in the commodity mix of trade, differences in per capita income, time differentials, differences in the degree of commonality of language, and differences in past flows of direct investment -- each is likely to result in a pattern of distribution of telecommunications that is significantly different from the trade pattern. One way of examining the possible magnitude of these demand-generated differences is to compare the telephone message/trade volume ratios for the United States and Canada. Ratios for the year 1960 for the interregional links involving the two countries are presented in Table 3. While the relative adequacy of telecommunications facilities between the United States and any given foreign point is not identical with the relative adequacy of the facilities linking Canada and the same foreign location, the relative conditions of supply in 1960 appear to have been sufficiently similar over most links to warrant the conclusion that a large part of the differences between the ratios of telephone traffic to trade for the United States and Canada was the result of differences in the intensity of demand.

If discussion is limited to those routes included in Table 3, both Canadian and U.S. traffic to all non-European points was carried over high-frequency radiotelephone circuits of much the same quality of signal and with relatively long waiting periods between the time of initiation of call and the time an overseas connection was established. The number of points for which Canadian customers were provided direct circuits rather than circuits via a relay point seems to have been not much less than the number of direct circuits available to telephone subscribers in the United States. Messages between the United Kingdom and Canada were carried over circuits (in the TAT-1 cable) that are owned by the Canadian overseas telecommunications authorities. Prior to the installation of Time Assignment Speech Interpolation equipment (TASI) in June of 1960 the traffic densities on the Canadian and U.S. circuits derived from TAT-1 were apparently similar. During the last six months of 1960 the Canadian trunks were probably somewhat more crowded than the trunks terminating in the United States.

In spite of the similarity in the relative supply conditions for the United States and Canada over most overseas links in 1960, there are roughly twice as many telephone messages per dollar of trade over the routes involving the United States as over the routes involving

Table 3

RATIOS OF THE VOLUME OF INTERREGIONAL TELEPHONE TRAFFIC TO VALUE OF INTERREGIONAL TRADE FOR THE UNITED STATES AND CANADA

Ratios for U.S. Traffic (messages per million of 1960 U.S. dollars of trade)		Ratios for Canadian Traffic (messages per million of 1960 U.S. dollars of trade)	
U.S.-Europe	93.5	Canada-Europe	43.6
U.S.-South America	37.2	Canada-South America	18.4
U.S.-Oceania	48.0	Canada-Oceania	20.7
U.S.-Japan	29.2	Canada-Japan	17.9
U.S.-Rest of East Asia	55.3	Canada-Rest of East Asia	12.2
U.S.-South Asia	6.0	Canada-South Asia	3.7
U.S.-Middle East	20.0	Canada-Middle East	4.2
U.S.-South Africa	7.3	Canada-South Africa	11.5
U.S.-Rest of Africa	5.4	Canada-Rest of Africa	9.0

Sources:

Interregional Trade: United Nations, Yearbook of International Trade Statistics, 1960, New York: United Nations, 1962.

Interregional Telephone Message Volume: Estimates provided privately by the American Telephone and Telegraph Company.

Canada. The important exceptions to this rough proportionality are the links to Africa and East Asia. As suggested earlier, the presence of United States military forces in certain East Asian areas leads to a very large volume of telephone traffic, and it is this factor that probably accounts for the very high volume of United States traffic relative to Canadian traffic in this region. The reasons for the relatively high volume of telephone messages between Canada and Africa in comparison with United States-African traffic are not clear. Given the small amount of traffic, the errors of estimation of traffic volume are likely to be important and it is thus possible that the differences here are fictitious rather than real.

If the conditions of supply of telecommunications services, the time differential, and language factors are roughly the same for the United States and Canada why then are there such large differences in the volume of telephone messages relative to trade volume between the two countries? A relatively larger volume of telecommunications arising from tourism may provide a partial explanation. The communications policies of United States firms with respect to mode of communication may differ from the policies of Canadian firms. The ratio of total overseas telex traffic to total overseas trade in 1960 was somewhat higher for the United States than for Canada, but only by some 40 per cent instead of the roughly 100 per cent difference characteristic of telephone traffic. By 1962, however, it appears that the volume of United States overseas telex traffic had increased to the point where the difference between United States and Canadian telex/trade ratios was approximately equal to the difference in telephone/trade ratios. Whether or not it is the relative affluence of the United States, the difference in size of the firms engaged in overseas trade, the relatively greater volume of United States overseas investment, or simply the larger volume of telecommunications having their origin in the communications needs of government and the private nonbusiness sector that is responsible for these differences in telecommunications/trade ratios is not certain, but the data do point up the possibilities of wide divergences of patterns of telecommunications from trade patterns that are not the result of differences in the conditions of supply.

III. THE LONG-RUN RELATIONSHIP BETWEEN CHANGES IN THE VOLUME OF OVERSEAS TELECOMMUNICATIONS AND CHANGES IN THE VOLUME OF OVERSEAS TRADE

It was shown in Section II that the distribution of telecommunications traffic at a moment of time is not closely related to the distribution of trade. This does not, however, imply that changes in the volume of telecommunications through time are not closely related to changes in the volume of trade. The differences in the distributions of trade and telecommunications that are observed in 1960 may be differences that developed prior to 1950, and the changes in trade and telecommunications since 1950 may be closely related. To investigate this possibility the time series for trade and telecommunications must be examined. Unfortunately, the time series on telecommunications traffic are not available for most of the countries of the world. The data examined here therefore relate to the experience of the United States only. The data on commodity trade are rather crude estimates of the value of trade at constant prices. Price deflators for the trade between the United States and particular countries were not available, and the more general export price indexes calculated by the Statistical Office of the U.N. Department of Economic and Social Affairs were therefore employed. The total value of trade between the United States and country X in the year t was thus calculated as the sum of (a) United States exports to country X deflated by the price index for all United States exports in the year t and (b) United States imports from country X deflated by the price index for all country X exports during the year t.

The simplest method of testing for the existence of an association between trade and the volume of telecommunications is to estimate the rank correlation between these variables. The rank correlation between the absolute values of change in trade and telecommunications volume is not particularly meaningful, however, because of the extreme differences in the size of the countries which are our units of observation. Large changes in telecommunications volume will be associated with large changes in trade simply because the unit of observation is large. A more informative estimate is the rank correlation between rates of increase of trade and telecommunications. For a sample of 28 European, South American, Asian, and Oceania nations the rank correlation between rates of growth of trade and telephone traffic over the period 1950-1960 is .47. The rank correlation between rates of growth of trade and message telegraph traffic for the same time period and sample is .55. For one-tail tests the first figure is significant at the 95 per cent confidence level and the second is significant at the 99 per cent level. Considered alone, these figures suggest a fairly strong degree of association, but if the decade 1950-1960 is broken into the successive quinquennia 1950-1955 and 1955-1960, much less significant results are obtained. The rank correlation between rates of growth of trade and telephone traffic is .21 for the period 1950-1955 and .28 for the period 1955-1960. The rank correlation between rates of growth of telegraph traffic and trade is .36 for the period 1950-1955 and .43 for the period 1955-1960. Only the coefficients relating to telegraph traffic are significant at the 95 per cent confidence level for a one-tail test.

The question of interest, however, is not whether or not a relationship between changes in trade and changes in telecommunications exists but the quantitative importance of such a relationship. Given the suspicion that there are important determinants of the volume of telecommunications other than trade, the simplest model likely to be useful is a model which postulates the existence of two types of overseas telecommunications: (1) traffic related to commodity trade, and (2) traffic that is unrelated to trade and that can be expressed as a function of time. If the factors that determine the size of the latter submarket are presumed to operate with an effect that is proportional to the size of that submarket, the model for the total overseas telecommunications market is expressed by the equation

$$Y_{i_t} = a_1 Y_{i_0} e^{rt} + b_1 X_{i_t} + u_{i_t} , \qquad (3.1)$$

where Y_{i_t} is the volume of telecommunications between the United States and the "i^{th}" country during the year t and Y_{i_0} is the volume of telecommunications between the United States and the i^{th} country during the base year 0, X_{i_t} is the volume of trade in constant prices between the United States and the i^{th} country during the year t, r is the (continuous) rate of growth of that portion of total telecommunications traffic that is unrelated to commodity trade, u_{i_t} is the error term for the i^{th} country in year t, and a_1 and b_1 are the parameters of the equation.

Since the variable of interest is the change in the volume of telecommunications over time rather than the volume at any moment of time, the appropriate form of the basic model is given by the equation

$$(Y_{i_t} - Y_{i_0}) = a_1 Y_{i_0}(e^{rt}-1) + b_1(X_{i_t} - X_{i_0}) + u_{i_t} . \qquad (3.2)$$

For any fixed time period this can be expressed in the form

$$(Y_{i_t} - Y_{i_0}) = a_2 Y_{i_0} + b_1(X_{i_t} - X_{i_0}) + u_{i_t} , \qquad (3.3)$$

since e^{rt} is a constant rather than a variable if r and t are the same for all observations.

It may be the case that the experiences in traffic growth between the United States and various foreign points are so different in their nature that the sample of observations that have been collected here cannot be viewed as a sample of observations from the same population. In particular, the assumption that the "autonomous" rates of growth of traffic are identical between routes or countries may prove unwarranted. One way of examining the question of the homogeneity of the sample is to compare the results of regressions of the form (3.3) with the results of regressions of the form given by the equation

$$(Y_{i_t} - Y_{i_0})/Y_{i_0} = a_2 + b_1(X_{i_t} - X_{i_0})/Y_{i_0} + u_{i_t} \quad . \qquad (3.4)$$

This equation can be interpreted as a regression model of the rate of increase of telecommunications on the rate of increase of trade where the rate of increase of trade is weighted by the initial trade/telecommunication ratio.

If the assumptions of the original model, equation (3.1), are warranted, the estimates of the relationship between changes in the volume of telecommunications and changes in the volume of trade obtained through regressions of the forms given by equations (3.3) and (3.4) should be consistent. If the estimates differ widely, and if the true relationship when expressed in the form of equation (3.3) is linear homogeneous, the differences in the regression coefficients calculated for models of the form of equations (3.3) and (3.4) probably reflect the fact that the observations come from different populations and that the distribution of observations by type of population is not independent of the distribution of observations by size.* The original data are not distributed normally as to size, and given the extreme variation in the size of the observations, those observations relating to the largest countries will tend to dominate

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*Where the true relationship is of the linear homogeneous form

$$(Y_{i_t} - Y_{i_0}) = \alpha Y_{i_0} + \beta (X_{i_t} - X_{i_0}) + u_t$$

the regression equations

$$(Y_{i_t} - Y_{i_0}) = a_1 Y_{i_0} + b_1(X_{i_t} - X_{i_0}) \text{ and}$$

$$(Y_{i_t} - Y_{i_0})/Y_{i_0} = a_2 + b_2(X_{i_t} - X_{i_0})/Y_{i_0}$$

both provide unbiased estimates of α and β. If the problem of errors in the variables is ignored, the problem of spurious correlation (or spurious lack of correlation) of ratios occurs only if the true relationship is nonhomogeneous.

the estimates for the regression coefficients calculated for the entire sample. If the experience of these countries is in some way quite different from that of the remaining nations the characteristics of the larger nations will be incorrectly imputed as applying also to the smaller countries.

With these considerations in mind, regressions of the absolute changes in telephone or telegraph volume against the initial volume of traffic and the absolute change in trade, and regressions of rates of increase in telephone or telegraph traffic against rates of increase of trade weighted by initial ratios of trade to telephone or telegraph volume, were calculated from the 1950-1960 data for a world-wide sample of 28 countries and two subsamples -- 12 countries of Western Europe and 8 countries of South America. These two sets of regressions are based on the models given in equations (3.3) and (3.4) respectively. The estimates of the parameters of these equations are summarized in Table 4. The parameter of paticular interest to this study is the regression coefficient b_1 of equations (3.3) and (3.4) which relates changes in telecommunications volume or rates of increase of telecommunications volume to changes in trade or weighted rates of increase of trade. This coefficient is an estimate of the partial derivative of telecommunications with respect to trade -- and estimate of the increment to the volume of telecommunications associated with a given increment to the volume of trade when the other determinants of telecommunications are assumed fixed.

Since there have been substantial differences in changes in supply conditions in the period 1950-1960 between the various overseas routes involving the United States, it is doubtful a priori whether regressions of the rigid form given by equations (3.3) or (3.4) will explain as much of the variation in telecommunications growth for a world-wide sample as for a regional sample. This hypothesis is supported by a comparison of the regressions for the sample of 28 countries (regressions 1 to 4 of Table 4) with the regressions for the subsample of 12 European countries (regressions 5 to 12 of

Table 4

REGRESSIONS OF CHANGES OF U.S.-OVERSEAS TELECOMMUNICATIONS TRAFFIC ON CHANGES OF U.S.-OVERSEAS COMMODITY TRADE FOR SELECTED LINKS, 1950-1960[a]

I. Sample of 28 countries

A. Telephone traffic

With a model of form

$$(Y_{i_1} - Y_{i_0}) = a + b_1 Y_{i_0} + b_2 (X_{i_1} - X_{i_0}) + u_i$$

the fitted regression is

$$(1) \quad (Y_{i_1} - Y_{i_0}) = - 12.7 \times 10^3 + 2.36\, Y_{i_0} + .14 \times 10^{-4} (X_{i_1} - X_{i_0})$$

with $r^2 = .69$ and $s_{b_2} = .23 \times 10^{-4}$.

With a model of form

$$(Y_{i_1} - Y_{i_0})/Y_{i_0} = a + b\, (X_{i_1} - X_{i_0})/Y_{i_0} + u_i$$

the fitted regression is

$$(2) \quad (Y_{i_1} - Y_{i_0})/Y_{i_0} = 1.16 + .23 \times 10^{-4} (X_{i_1} - X_{i_0})/Y_{i_0}$$

with $r^2 = .10$ and $s_b = .14 \times 10^{-4}$.

B. Telegraph traffic

With a model of form

$$(Z_{i_1} - Z_{i_0}) = a + b_1 Z_{i_0} + b_2 (X_{i_1} - X_{i_0}) + u_i$$

the fitted regression is

$$(3) \quad (Z_{i_1} - Z_{i_0}) = -.71 \times 10^4 + .086\, Z_{i_0} + .33 \times 10^{-3} (X_{i_1} - X_{i_0})$$

with $r^2 = .67$ and $s_{b_2} = .07 \times 10^{-3}$.

Table 4 (continued)

With a model of form

$$(Z_{i_1} - Z_{i_0})/Z_{i_0} = a + b\,(X_{i_1} - X_{i_0})/Z_{i_0} + u_i$$

the fitted regression is

$$(4)\quad (Z_{i_1} - Z_{i_0})/Z_{i_0} = .08 + .39 \times 10^{-3}\,(X_{i_1} - X_{i_0})/Z_{i_0}$$

with $r^2 = .47$ and $s_b = .08 \times 10^{-3}$.

II. Sample of 12 European countries

A. Telephone traffic

With a model of form

$$(Y_{i_1} - Y_{i_0}) = a + b_1 Y_{i_0} + b_2\,(X_{i_1} - X_{i_0}) + u_i$$

the fitted regression is

$$(5)\quad (Y_{i_1} - Y_{i_0}) = -20.8 \times 10^3 + 2.05\,Y_{i_0} + .87 \times 10^{-4}\,(X_{i_1} - X_{i_0})$$

with $r^2 = .95$ and $s_{b_2} = .25 \times 10^{-4}$.

Introducing a dummy variable such that

$$(Y_{i_1} - Y_{i_0}) = a_1 + b_1 Y_{i_0} + b_2\,(X_{i_1} - X_{i_0}) + u_i \text{ for } i = a,b,$$

$$= a_2 + b_1 Y_{i_0} + b_2\,(X_{i_1} - X_{i_0}) + u_i \text{ for } i \neq a,b,$$

the fitted regression is

$$(6)\quad (Y_{i_1} - Y_{i_0}) = 77.3 \times 10^3 + 1.86\,Y_{i_0} + .27 \times 10^{-4}\,(X_{i_1} - X_{i_0}) \text{ for}$$

the United Kingdom and Germany,

$$= -5.1 \times 10^3 + 1.86\,Y_{i_0} + .27 \times 10^{-4}\,(X_{i_1} - X_{i_0}) \text{ for}$$

other countries,

with $r^2 = .97$ and $s_{b_2} = .30 \times 10^{-4}$.

Table 4 (continued)

With a model of form

$$(Y_{i_1} - Y_{i_0})/Y_{i_0} = a + b\ (X_{i_1} - X_{i_0})/Y_{i_0} + u_i$$

the fitted regression is

$$(7)\quad (Y_{i_1} - Y_{i_0})/Y_{i_0} = 1.51 + .47 \times 10^{-4}\ (X_{i_1} - X_{i_0})/Y_{i_0}$$

with $r^2 = .28$ and $s_b = .24 \times 10^{-4}$.

Introducing a dummy variable such that

$$(Y_{i_1} - Y_{i_0})/Y_{i_0} = a + b_1(1/Y_{i_0}) + b_2(X_{i_1} - X_{i_0})/Y_{i_0} + u_i \text{ for } i = a,b,$$

$$= a + b_2(X_{i_1} - X_{i_0})/Y_{i_0} + u_i \text{ for } i \neq a,b,$$

the fitted regression is

$$(8)\quad (Y_{i_1} - Y_{i_0})/Y_{i_0} = 1.30 + .72 \times 10^5/Y_{i_0} + .48 \times 10^{-4}\ (X_{i_1} - X_{i_0})/Y_{i_0}$$

for the United Kingdom and Germany,

$$= 1.30 + .48 \times 10^{-4}\ (X_{i_1} - X_{i_0})/Y_{i_0} \text{ for other countries,}$$

with $r^2 = .39$ and $s_{b_2} = .24 \times 10^{-4}$.

B. Telegraph traffic

With a model of form

$$(Z_{i_1} - Z_{i_0}) = a + b_1\ Z_{i_0} + b_2\ (X_{i_1} - X_{i_0}) + u_i$$

the fitted regression is

$$(9)\quad (Z_{i_1} - Z_{i_0}) = -3.9 \times 10^4 - .002\ Z_{i_0} + .63 \times 10^{-3}\ (X_{i_1} - X_{i_0})$$

with $r^2 = .89$ and $s_{b_2} = .11 \times 10^{-3}$.

Introducing a dummy variable such that

$$(Z_{i_1} - Z_{i_0}) = a_1 + b_1 Z_{i_0} + b_2(X_{i_1} - X_{i_0}) + u_i \text{ for } i = a,b,$$

$$= a_2 + b_1 Z_{i_0} + b_2(X_{i_1} - X_{i_0}) + u_i \text{ for } i \neq a,b,$$

Table 4 (continued)

the fitted regression is

$$(10)\quad (Z_{i_1} - Z_{i_0}) = 2.37 \times 10^5 - .01\, Z_{i_0} + .44 \times 10^{-3}\,(X_{i_1} - X_{i_0}) \text{ for}$$

the United Kingdom and Germany,

$$= .45 \times 10^4 - .01\, Z_{i_0} + .44 \times 10^{-3}\,(X_{i_1} - X_{i_0}) \text{ for}$$

the other countries,

with $r^2 = .91$ and $s_{b_2} = .18 \times 10^{-3}$.

With a model of form

$$(Z_{i_1} - Z_{i_0})/Z_{i_0} = a + b\,(X_{i_1} - X_{i_0})/Z_{i_0} + u_i$$

the fitted regression is

$$(11)\quad (Z_{i_1} - Z_{i_0})/Z_{i_0} = -.01 + .53 \times 10^{-3}\,(X_{i_1} - X_{i_0})/Z_{i_0}$$

with $r^2 = .67$ and $s_b = .12 \times 10^{-3}$.

Introducing a dummy variable such that

$$(Z_{i_1} - Z_{i_0})/Z_{i_0} = a + b_1(1/Z_{i_0}) + b_2(X_{i_1} - X_{i_0})/Z_{i_0} + u_i \text{ for } i = a,b,$$

$$= a + b_2(X_{i_1} - X_{i_0})/Z_{i_0} + u_i \text{ for } i \neq a,b,$$

the fitted regression is

$$(12)\quad (Z_{i_1} - Z_{i_0})/Z_{i_0} = .08 + .29 \times 10^6/Z_{i_0} + .34 \times 10^{-3}\,(X_{i_1} - X_{i_0})/Z_{i_0}$$

for United Kingdom and Germany,

$$= .08 + .34 \times 10^{-3}\,(X_{i_1} - X_{i_0})/Z_{i_0} \text{ for other countries,}$$

with $r^2 = .75$ and $s_b = .16 \times 10^{-3}$.

III. Sample of 8 South American countries

A. Telephone traffic

With a model of form

$$(Y_{i_1} - Y_{i_0}) = a + b_1 Y_{i_0} + b_2\,(X_{i_1} - X_{i_0}) + u_i$$

Table 4 (continued)

the fitted regression is

(13) $(Y_{i_1} - Y_{i_0}) = 8.3 \times 10^3 + .08\, Y_{i_0} + .23 \times 10^{-4}\, (X_{i_1} - X_{i_0})$

with $r^2 = .29$ and $s_{b_2} = .16 \times 10^{-4}$.

With a model of form

$(Y_{i_1} - Y_{i_0})/Y_{i_0} = a + b\, (X_{i_1} - X_{i_0})/Y_{i_0} + u_i$

the fitted regression is

(14) $(Y_{i_1} - Y_{i_0})/Y_{i_0} = .79 + .34 \times 10^{-4}\, (X_{i_1} - X_{i_0})/Y_{i_0}$

with $r^2 = .48$ and $s_b = .15 \times 10^{-4}$.

B. Telegraph traffic

With a model of form

$(Z_{i_1} - Z_{i_0}) = a + b_1 Z_{i_0} + b_2\, (X_{i_1} - X_{i_0}) + u_i$

the fitted regression is

(15) $(Z_{i_1} - Z_{i_0}) = 5.85 \times 10^4 - .20\, Y_{i_0} + .48 \times 10^{-3}\, (X_{i_1} - X_{i_0})$

with $r^2 = .82$ and $s_b = .11 \times 10^{-3}$.

With a model of form

$(Z_{i_1} - Z_{i_0})/Z_{i_0} = a + b\, (X_{i_1} - X_{i_0})/Z_{i_0} + u_i$

the fitted regression is

(16) $(Z_{i_1} - Z_{i_0})/Z_{i_0} = .16 + .19 \times 10^{-3}\, (X_{i_1} - X_{i_0})/Z_{i_0}$

with $r^2 = .15$ and $s_b = .18 \times 10^{-3}$.

Note and Sources:

See next page.

Definition of symbols:

Y_{i_1} = Number of telephone messages between the United States and an i^{th} country in 1960.

Y_{i_0} = Number of telephone messages between the United States and an i^{th} country in 1950.

X_{i_1} = Value of commodity trade in U.S. dollars between the United States and and i^{th} country in 1960 stated in terms of 1953 prices.

X_{i_0} = Value of commodity trade in U.S. dollars between United States and an i^{th} country in 1950 states in terms of 1953 prices.

Z_{i_1} = Number of telegraph messages between the United States and an i^{th} country in 1960.

Z_{i_0} = Number of telegraph messages between the United States and an i^{th} country in 1950.

r = The (continuous) rate of growth of that portion of total telecommunications traffic that is unrelated to trade.

s_b = The standard error of estimate of the coefficient "b".

a, b_1, b_2 = Parameters of the equations.

r^2 = Coefficient of (multiple) determination.

Note:

[a]Given the focus of interest, standard errors of estimate for coefficients other than those relating to trade and telecommunications are not reported.

Sources:

Commodity Trade: U.S. Department of Commerce, Statistical Abstract of the United States, 1962, Washington: Government Printing Office, 1962.

Price Indexes for Commodity Trade: United Nations, Yearbook of International Trade Statistics, 1960, New York: United Nations, 1962.

Telephone Traffic: Federal Communications Commission, Statistics of Communications Common Carriers, 1960, Washington: Government Printing Office, 1962; W. Meckling and S. Reiger, Communications Satellites: An Introductory Survey of Technology and Economic Promise, The RAND Corporation, RM-2709-NASA, September 1960.

Table 4). The coefficient of determination for the regression of changes of telephone traffic on changes in trade given by the model

$$(Y_{i_t} - Y_{i_0}) = a + b_1 Y_{i_0} + b_2(X_{i_t} - X_{i_0}) + u_{i_t}$$

is .69 for the world-wide sample (regression 1 of Table 4) and .95 for the European sample (regression 5 of Table 4). Similar results are noticed for the regression of changes of telegraph traffic on trade and the regressions of rates of change of telephone or telegraph traffic on weighted rates of change of trade (regressions 2, 3, and 4 of Table 4 for the world-wide sample and regressions 7, 9, and 11 for the sample of European countries). In each case the regressions on the data of the subsample yield the higher coefficient of determination. Examination of the residuals of the regressions on the world-wide sample suggests that the residuals are not distributed independently of the geographical location of the observations, particularly for the regressions of absolute changes and rates of change of telephone traffic on absolute changes and weighted rates of change of trade.

Analysis of the data on a regional basis would therefore appear to be more useful, yet modification of the basic estimating equations may be required even when the sample of observations is restricted to the countries of a particular region. Comparison of the residuals for regression 5 of Table 4 -- the regression of absolute changes in telephone traffic on absolute changes in trade for the European subsample -- suggests that the large value for the estimate of the coefficient relating changes in telephone traffic to changes in trade derives from the need to explain the very high rates of growth of telephone traffic to the United Kingdom and Germany, the two largest countries of the subsample. If a dummy variable (taking the value of 1 for the observations for the UK and Germany and 0 for all other observations) is introduced into the regression equation to allow for the possibility that the "autonomous" changes in telephone traffic to these two countries are far larger than to other countries,* rather different estimates of the relationship between changes of telephone traffic and changes in trade are obtained. The regressions in which a dummy variable is so introduced are shown as 6 and 10 of Table 4. In regressions 8 and 12 of Table 4, the dummy variable is introduced in deflated form, taking the value $(1/Y_{i_0})$ for the UK and Germany and zero for other countries. With a two-tail test the regression coefficient for the dummy variable is significantly different from zero at the 95 per cent confidence level for the regression relating absolute changes of telephone traffic and trade (regression 6). They are not significant at the 95 per cent confidence level for the regressions relating rates of change (regressions 8 and 12) or for the regression of absolute changes of telegraph traffic and trade (regression 10).

With respect to the question of the similarity of the coefficients relating trade and telephone traffic in the two models, original equations (3.3) and (3.4), relating absolute changes and rates of increase, it turns out that the regressions modified by the introduction of the dummy variable yield estimates that are more consistent than the estimates yielded by the regressions not so modified. The difference between the coefficient b_2 of the modified regression 6 of Table 4 and the coefficient b_2 of the modified regression 8, is less than the difference between the coefficient b_2 of regression 5 and the coefficient b of regression 7. Comparison of the relevant coefficients for the regressions of telegraph traffic (regressions 9 to 12 of Table 4) does not yield the same conclusion. The estimates of the coefficients relating trade and telegraph traffic according to alternative models modified by introduction of the dummy variable differ as much as do the relevant estimates of the unmodified equations. For telephone traffic the difference between (a) the

*This possibility is plausible _a priori_ on the grounds of common language with the United Kingdom and the presence of large numbers of United States military personnel in Germany.

coefficients relating absolute changes in telecommunications to absolute changes of trade and (b) the coefficients relating these changes when the changes are deflated by the initial volume of telecommunications, is less than the standard error of estimate of either coefficient when the estimating equation includes the dummy variable. When the regression model does not include the dummy variable the difference between the estimates of the coefficient relating trade and telephone traffic yielded by the two estimating equations is nearly twice the standard error of either estimate.

The regressions obtained from the data for the subsample of eight South American countries do not explain a very large part of the variation in telecommunications traffic to that region. The telecommunications experience between the United States and these nations is too diverse to be handled within the framework of a simple model such as that given by equations (3.3) or (3.4). The coefficient relating changes in telephone traffic to changes in trade (the estimate of b_2 in regression 13 of Table 4) is consistent with the coefficient relating rates of increase or deflated increases (the estimate of b in regression 14), but the former estimate derives mainly from the experience of Venezuela. If regression 13 is recomputed without the observations for Venezuela, the estimate of the partial relationship between trade and telephone traffic for the remaining seven countries is negative, although not significantly so at the 90 per cent confidence level. As nearly half of the total trade between the United States and Venezuela is in bulk petroleum products, it is questionable that Venezuela should be included in the sample. If Venezuela is excluded, both the coefficient relating changes in telegraph traffic to changes in trade, and the coefficient relating changes in telephone traffic to changes in trade (the coefficients b_2 in regressions 13 and 15 of Table 4) do not differ significantly from zero at the 90 per cent confidence level. Either the relationship between trade and telecommunications is quantitatively unimportant or the estimating models are inadequate. The small number of observations is a barrier to more complex formulations.

Perhaps the most striking finding of the regression analysis of the 1950-1960 changes in trade and telecommunications between countries is not observable in Table 4, because the results of regressions of the form

$$(Y_{i_t} - Y_{i_0}) = a + bY_{i_0} + u_{i_t} \tag{3.5}$$

are not given there. Regressions of the form of equation (3.5), which do not include the trade variable, explain virtually as much of the variation in changes of telephone traffic between countries as the regressions of the form of equation (3.3), which do include the trade variable. In other words, a simple trend model appears to be almost as useful as a model that allows for changes in trade. For example, the coefficient of determination yielded by regression 1 of Table 4 is .690 for the world-wide sample. The coefficient of determination yielded by a regression equation of the form of equation (3.5) is .686 for the same data. The coefficient of determination yielded by the more inclusive model given by equation (3.3) for the regression of changes of telephone traffic on changes of trade for the European subsample (regression 5 of Table 4) is .947. The corresponding coefficient of determination yielded by the simple trend model given by equation (3.5) is .889. If equation (3.5) is modified by the addition of a dummy variable, the coefficient of determination for the regression of changes in telephone traffic to Europe on the dummy variable and the initial volume of telephone traffic is .967. Inclusion of the changes in trade in the model as was done in regression 6 of Table 4 results in a coefficient of determination of .970.

The initial volume of telephone traffic and the change in trade are collinear, of course, but that is not the sole reason for the similarity in results given by regression models of the forms of equations (3.3) and (3.5). A simple regression of the form given by the equation

$$(Y_{i_t} - Y_{i_0}) = a + b(X_{i_t} - X_{i_0}) + u_{i_t} \quad , \tag{3.6}$$

which excludes the initial volume of traffic as an explanatory variable, consistently explains less of the variation in the changes of telephone traffic between countries than does a simple trend model of the form of equation (3.5). For the world-wide sample, a regression of the form of equation (3.6) yields a coefficient of determination of .432. The relevant coefficient of determination for a model of the form of equation (3.5) is .686. As already mentioned, the regression of the form of equation (3.5) on the changes of telephone traffic to Europe gives a coefficient of determination of .967 when the regression is modified by the introduction of a dummy variable taking the value 1 for traffic to the United Kingdom and Germany, and 0 for other traffic. If a regression on the same data of the form of equation (3.6) is modified in the same way, the resulting coefficient of determination is .877. The difference between (a) the multiple coefficient of determination yielded by the inclusive models based on equation (3.3), and (b) the coefficient of determination given by a simple trend model of the form of equation (3.5) is not significant at the 95 per cent confidence level. This is true for both the regression for the world-wide sample and the regression for the European subsample modified through inclusion of the dummy variable. This statement simply reflects the fact that the coefficients b_2 in regressions 1 and 6 of Table 4 are not significantly different from zero at that confidence level. The coefficients of determination for regression models of the form of equations (3.3), (3.5), and (3.6) are summarized in the following table.

	Coefficients of Determination (r^2)		
Sample of Countries	Trade plus "Trend" Model: Equation (3.3)	Simple "Trend" Model: Equation (3.5)	Simple Trade Model: Equation (3.6)
World-wide	.690	.686	.432
European	(a) .947 (b) .970	(a) .889 (b) .967	(a) .829 (b) .877

The coefficients calculated for the sample of European countries which are preceded by the prefix (b) were calculated for models of the type indicated which were amended to include a dummy variable taking the value (0, 1). The coefficients prefixed by (a) are calculated for models that are not amended in this way.

Quite different results are obtained for regressions of telegraph traffic, however. Whereas a simple trend model explains more of the variation in changes of telephone traffic between countries than does a simple trade model of the form of equation (3.6), the reverse is true in the case of telegraph service. For the world-wide sample a trend model of the form of equation (3.5) gives a coefficient of determination of .39. The coefficient of determination yielded by a simple trade model -- equation (3.6) -- is .64, virtually as high as the .67 coefficient of determination given by the more inclusive model (regression 3 of Table 4) of the form of equation (3.3). The comparative results of regressions on data of the European subsample are even more striking. The simple trend model yields a coefficient of determination of .455. The coefficient of determination of the simple trade model of the form of equation (3.6) is .887, almost as high as the .888 multiple coefficient of determination for the combined trend and trade model reported as regression 9 of Table 4. These findings are reflected in Table 4 in that the ratio of the coefficient b_2 to its standard error in regressions 3, 9, and 10, in each case is such that b_2 is significantly different from 0 at the 95 per cent confidence level.

The results of this regression analysis must be used with great care. The possibility that the regression coefficients are distorted as a result of differences in the "autonomous" changes in the volume of telecommunications that are not taken into account in the rather simple models utilized in this analysis has been mentioned. In addition, there is likely to be considerable heterogeneity in the partial trade-telecommunications relationship between nations. This is not allowed for in the estimating equations. There is also no assurance that the relationship between trade and telecommunications is not a function of the same unidentified variables that have been lumped together as the time trend. Specifically, the partial derivative of telecommunications with respect to trade may not be constant but may be a function of time. This question will be discussed in Section IV. A final note of caution is due with respect to the possibility that the so-called autonomous change in the volume of telecommunications -- that change in the volume of telecommunications between the United States and a particular country that persists at a more or less even rate through time and which is independent of the changes in trade between that country and the United States -- is itself dependent upon the existence of a generally expanding world volume of overseas trade. That is, the factors responsible for this autonomous change may themselves be dependent upon the general long-term trend in world-wide commodity trade. If so, the importance of changes in trade to the market for telecommunications has been underestimated.

The findings of regression analysis of changes of trade and telephone traffic are thus largely negative. The standard errors of estimate of the magnitude of the partial effect of changes of trade on changes in telephone traffic are such that the estimates are not significantly different from zero at the 95 per cent confidence level for one-tail tests for any of the samples examined here. The conclusion that relatively little of the differences in changes of telephone traffic over time between countries can be explained in terms of changes in trade does not, however, depend only upon the fact that the standard errors of estimate are large relative to the value of the estimates themselves. If the estimate of the value of b_2 in regression 6 for the European subsample is accepted, changes in trade account for only 20 per cent of the total changes in telephone traffic. The absolute effect of changes in trade (or, rather of the complex of changes associated with trade changes) on the volume of telephone traffic to Europe is estimated in this regression to be an additional 27 telephone messages per additional $1 million in trade in 1953 prices. Estimates of the partial effect of changes in trade on changes in telephone traffic to other areas are even less reliable, but the fragmentary evidence suggests that the effect of changes in trade on changes in telephone traffic to points outside Europe is even less important than it is for traffic to Europe.

However, the estimates of the partial effect of changes of trade on changes in telegraph traffic for the world-wide and European samples (the coefficient b_2 of regressions 3, 9, and 10 of Table 4) are significantly different from zero at the 95 per cent confidence level, and the great bulk of the changes of telegraph traffic is accounted for in terms of changes of trade if the estimate of the regression coefficient is accepted. According to regression 3, 75 per cent of the increase in the volume of telegraph traffic to the 28 countries of the total sample during the period 1950-1960 is accounted for by trade increases. Accepting the estimate of regression 10, about 85 per cent of the increase in telegraph traffic to Europe is accounted for by trade increases.

These results were obtained with linear regressions of changes in telecommunications traffic on only two independent variables. Two questions thus come to mind. First, would nonlinear regression explain more of the variation in the dependent variable than linear regression? Second, would the inclusion of additional variables such as distance result in a significantly different estimate of the partial effect of changes in trade on changes in telecommunications? With respect to the first question, the finding is that simple linear regressions explain about as much of the variation in the dependent variable as do simple nonlinear regressions except for the sample of European countries. For this sample a simple linear model modified by inclusion of a dummy variable taking the value 1 for the two largest countries and 0 for all others seems as adequate as a simple nonlinear regression. With respect to the second question, it is found that inclusion of distance as a variable does not result in significantly different estimates of the regression coefficient relating changes in overseas trade to changes in telecommunications.

IV. THE RELATIONSHIP BETWEEN OVERSEAS TRADE AND TELECOMMUNICATIONS IN THE SHORT RUN

The analysis of the preceding section has been concerned with the relationship between changes in trade and changes in the volume of telecommunications between the United States and overseas points over a fairly long period -- the data from which the regressions were computed being the absolute increases and rates of increase of traffic between the United States and each of a set of overseas nations for the decade 1950-1960. A closely related but separate question is the relationship between short-run changes in trade and telecommunications. The data to be analyzed are the year-to-year changes in traffic between the United States and certain overseas regions. The distinction here is much the same as the distinction (familiar to economists) between the short-run and the secular relationship connecting changes in consumption with changes in personal disposable income.

It is not entirely clear from *a priori* reasoning whether the short-run effect of changes in the volume of trade on the volume of telecommunications can be expected to be systematically different from the long-run effect. Insofar as the capacity of telecommunications facilities relative to demand is such as to lead to a significant waiting time on overseas calls placed at times other than inconvenient hours, a short-run increase in the demand for telephone service will lead to a degradation of quality of service, and the number of messages completed will increase by a smaller proportion than demand. Changes in the physical capacity of telecommunications facilities occur discretely while demand can be expected to shift continuously. The effect of this constraint would be to reduce the apparent magnitude of the short-run trade effect. An additional reason for a discrepancy between estimates of the short-run and long-run effects of trade is the effect of price changes. There is some indication that the volume of telecommunications is related to the rate of change of prices. Other things being equal, a change in the volume of trade is likely to lead to a larger change in the volume of telecommunications the greater the rate of price change. As rapid changes of prices are associated with relatively large changes in the physical volume of trade, there will be some tendency, other things being equal, for the short-run trade effect to appear stronger than the long-run effect if there is substantial variation in the rate of increase of prices through time.

The model used here to provide an estimate of the short-run effect of changes of trade on telecommunications is derived directly from the basic model described in Section III. Where $Y_t = a_1 Y_0 e^{rt} + bX_t$, the yearly change in the volume of telecommunications is described by the equation

$$(Y_t - Y_{t-1}) = a_1 Y_0 \, [e^{rt} - e^{r(t-1)}] + b(X_t - X_{t-1}) \,, \qquad (4.1)$$

where $(Y_t - Y_{t-1})$ and $(X_t - X_{t-1})$ are the absolute increases in telecommunications volume and trade respectively during the year t and r is the autonomous rate of growth as defined in the preceding section. Because of convenience in the estimation of linear forms, the regressions were actually fitted to equations of the form

$$(Y_t - Y_{t-1}) = a_2 + a_3 t + a_4 t^2 + b(X_t - X_{t-1}) \qquad (4.2)$$

if the rate of growth of telecommunications was judged substantial, or to the form

$$(Y_t - Y_{t-1}) = a_2 + a_3 t + b(X_t - X_{t-1}) \qquad (4.3)$$

if the rate of growth of telecommunications was sufficiently small that the bias likely to be introduced by the use of the more truncated form was judged insignificant. Regressions were also computed for the equations

$$Y_t = a_5 + a_6 t + a_7 t^2 + bX_t \qquad (4.4)$$

and

$$Y_t = a_5 + a_6 t + bX_t \,. \qquad (4.5)$$

The relative stability of the estimates of b, the estimate of the magnitude of the short-run effect of trade on telecommunications, for the two sets of estimating equations (4.2) and (4.4), and (4.3) and (4.5), provides a partial check on the usefulness of the assumptions of the basic model.

With one exception, regressions for equations of both types were calculated for data from each of the years in the period 1950-1961 for total overseas telephone and telegraph traffic involving the United States and for traffic on the following regional links: United States-Europe, United States-South America, and United States-Oceania. These regressions are presented in Table 5. Data for 1957 and 1960 were omitted in calculating the regression of changes of telephone traffic on changes of trade between the United States and Europe because of the large changes in message volume following completion of the transatlantic cables TAT-1 and TAT-2. The magnitude of these changes is such that estimates of the relationship between changes in trade and telecommunications for this link are likely to be severely distorted. The problem is, of course, that the great increase in traffic during a year immediately following the completion of a cable reflects an enormous change in quality of service. The trade data were deflated in the manner described in Section III.

The regression coefficients relating year-to-year changes in telephone traffic to year-to-year changes in trade for each of the regressions of the form of equations (4.2) and (4.3) are significant at the 95 per cent confidence level except the regression coefficient for total world traffic (regression 2 of Table 5). The significant coefficients are obtained from the regressions of the observations for the U.S.-Europe, U.S.-South America, and U.S.-Oceania routes. These are regressions 5, 9, and 13, respectively, of Table 5. The regression coefficients relating year-to-year changes in telegraph traffic to year-to-year changes in trade -- the coefficients obtained from regressions of the form of equation (4.2) or (4.3) -- are significant at the 95 per cent confidence level for each of the regional groups and for total world traffic. These are regressions 4, 7, 11, and 15 of Table 5.

Table 5

REGRESSIONS OF ANNUAL CHANGES OF U.S.-OVERSEAS TELECOMMUNICATIONS TRAFFIC ON ANNUAL CHANGES IN U.S.-OVERSEAS COMMODITY TRADE FOR THE PERIOD 1950-1961[a]

I. Telecommunications traffic between the United States and all overseas points other than Hawaii and the Caribbean islands.

A. Telephone traffic

For a model of form

$$Y_t = a + b_1 t + b_2 t^2 + b_3 X_t + u_t$$

the fitted regression is

(1) $Y_t = 4.10 \times 10^5 + .002 \times 10^5 t + .092 \times 10^5 t^2 + .13 \times 10^{-4} X_t$

with $r^2 = .99$ and $s_{b_3} = .11 \times 10^{-4}$.

For a model of form

$$(Y_1 - Y_{t-1}) = a + b_1 t + b_2 (X_t - X_{t-1}) + u_t$$

the fitted regression is

(2) $(Y_t - Y_{t-1}) = .23 \times 10^5 + .16 \times 10^5 t + .21 \times 10^{-4} (X_t - X_{t-1})$

with $r^2 = .69$ and $s_{b_2} = .14 \times 10^{-4}$.

B. Telegraph traffic

For a model of form

$$Z_t = a + b_1 t + b_2 X_t + u_t$$

the fitted regression is

(3) $Z_t = 1.17 \times 10^7 + .17 \times 10^6 t + .35 \times 10^{-3} X_t$

with $r^2 = .98$ and $s_{b_2} = .06 \times 10^{-3}$.

For a model of form

$$(Z_t - Z_{t-1}) = a + b(X_t - X_{t-1}) + u_t$$

Table 5 (continued)

the fitted regression is

(4) $(Z_t - Z_{t-1}) = .13 \times 10^6 + .40 \times 10^{-3}(X_t - X_{t-1})$

with $r^2 = .90$ and $s_b = .04 \times 10^{-3}$.

II. Telecommunications traffic between the United States and Europe

A. Telephone traffic

For a model of form

$(Y_t - Y_{t-1}) = a + b_1 t + b_2(X_t - X_{t-1}) + u_t$

with observations for 1957 and 1960 omitted, the fitted regression is

(5) $(Y_t - Y_{t-1}) = -.11 \times 10^5 + .146 \times 10^5 t + .18 \times 10^{-4}(X_t - X_{t-1})$

with $r^2 = .93$ and $s_{b_2} = .06 \times 10^{-4}$.

B. Telegraph traffic

For a model of form

$Z_t = a + b_1 t + b_2 X_t + u_t$

the fitted regression is

(6) $Z_t = 7.40 \times 10^6 + .192 \times 10^6 t + .19 \times 10^{-3} X_t$

with $r^2 = .96$ and $s_{b_2} = .10 \times 10^{-3}$.

For a model of form

$(Z_t - Z_{t-1}) = a + b(X_t - X_{t-1}) + u_t$

the fitted regression is

(7) $(Z_t - Z_{t-1}) = .13 \times 10^6 + .27 \times 10^{-3}(X_t - X_{t-1})$

with $r^2 = .58$ and $s_b = .08 \times 10^{-3}$.

Table 5 (continued)

III. Telecommunications traffic between the United States and South America

A. Telephone traffic

For a model of form

$Y_t = a + b_1 t + b_2 X_t + u_t$

the fitted regression is

(8) $Y_t = .56 \times 10^5 + .088 \times 10^5 t + .16 \times 10^{-4} X_t$

with $r^2 = .99$ and $s_b = .03 \times 10^{-4}$.

For a model of form

$(Y_1 - Y_{t-1}) = a + b(X_t - X_{t-1}) + u_t$

the fitted regression is

(9) $(Y_t - Y_{t-1}) = .091 \times 10^5 + .12 \times 10^{-4}(X_t - X_{t-1})$

with $r^2 = .57$ and $s_b = .04 \times 10^{-4}$.

B. Telegraph traffic

For a model of form

$Z_t = a + b_1 t + b_2 X_t + u_t$

the fitted regression is

(10) $Z_t = 1.97 \times 10^6 + .040 \times 10^5 t + .35 \times 10^{-3} X_t$

with $r^2 = .80$ and $s_{b_2} = .11 \times 10^{-3}$.

For a model of form

$(Z_t - Z_{t-1}) = a + b(X_t - X_{t-1}) + u_t$

the fitted regression is

(11) $(Z_t - Z_{t-1}) = .083 \times 10^4 + .37 \times 10^{-3}(X_t - X_{t-1})$

with $r^2 = .78$ and $s_b = .07 \times 10^{-3}$.

Table 5 (continued)

IV. Telecommunications traffic between the United States and Oceania

A. Telephone traffic

For a model of form

$$Y_t = a + b_1t + b_2t^2 + b_3X_t + u_t$$

the fitted regression is

$$(12)\quad Y_t = .64 \times 10^4 - .036 \times 10^3t + .12 \times 10^3t^2 + .067 \times 10^{-4}X_t$$

with $r^2 = .98$ and $s_{b_3} = .03 \times 10^{-4}$.

For a model of form

$$(Y_t - Y_{t-1}) = a + b_1t + b_2(X_t - X_{t-1}) + u_t$$

the fitted regression is

$$(13)\quad (Y_t - Y_{t-1}) = .255 \times 10^3t + .073 \times 10^{-4}(X_t - X_{t-1})$$

with $r^2 = .56$ and $s_{b_2} = .028 \times 10^{-4}$.

B. Telegraph traffic

For a model of form

$$Z_t = a + b_1t + b_2t^2 + b_3X_t + u_t$$

the fitted regression is

$$(14)\quad Z_t = 2.29 \times 10^5 + .111 \times 10^4t + .151 \times 10^4t^2 + .114 \times 10^{-3}X_t$$

with $r^2 = .97$ and $s_{b_3} = .068 \times 10^{-3}$.

For a model of form

$$(Z_t - Z_{t-1}) = a + b_1t + b_2(X_t - X_{t-1}) + u_t$$

the fitted regression is

$$(15)\quad (Z_t - Z_{t-1}) = .059 \times 10^5 + .183 \times 10^4t + .185 \times 10^{-3}(X_t - X_{t-1})$$

with $r^2 = .61$ and $s_{b_2} = .056 \times 10^{-3}$.

Table 5 (continued)

Definition of symbols:

Y_t = number of telephone messages during the year "t."

$Y_t - Y_{t-1}$ = increase in number of telephone messages during the year "t."

X_t = volume of trade in U.S. dollars during the year "t" stated in terms of 1953 prices.

$X_t - X_{t-1}$ = increase in volume of trade during the year "t" stated in terms of 1953 prices.

Z_t = number of telegraph messages during the year "t."

$Z_t - Z_{t-1}$ = increase in number of telegraph messages during the year "t."

r = the (continuous) rate of growth of that portion of total telecommunications traffic that is unrelated to trade.

s_b = the standard error of estimate of the coefficient "b."

a, b_1, b_2 = parameters of the equations.

r^2 = coefficient of (multiple) determination.

Note:

[a] Given the focus of interest the standard errors of estimate for coefficients other than those relating trade and telecommunications are not reported.

Sources:

Commodity Trade: U.S. Department of Commerce, Statistical Abstract of the United States, Washington: Government Printing Office, volumes for 1955, 1959, and 1962.

Price Indexes for Commodity Trade: United Nations, Yearbook of International Trade Statistics, 1960, New York: United Nations, 1962.

Telecommunications Traffic: Federal Communications Commission, Statistics of Communications Common Carriers, Washington: Government Printing Office, volumes for 1950 through 1961.

The coefficients relating trade and telecommunications volume for the regressions of current telecommunications volume against the volume of current trade are quite consistent with the corresponding coefficients obtained for the regressions of changes in telecommunications volume against changes in trade. For all traffic totals and for both modes of telecommunication the estimate of the short-run relationship between trade and telecommunications, which was derived from regressions of the form of equations (4.2) and (4.3), differs from the estimate of this relationship according to regressions of the form of equations (4.4) and (4.5) by no more than the standard error of estimate of either coefficient.

The regressions are such that the question of the difference between the short-run and long-run effects cannot be answered with any real degree of assurance. The coefficients relating short-run changes in trade to short-run changes in telephone traffic for all overseas links involving the United States is considerably less than the coefficient relating long-run changes in trade and telephone traffic calculated for the sample of 28 countries. However, the two coefficients are not comparable, for the sample coverage is different. The latter regression covers virtually all telephone traffic but only a portion of total trade. The inclusion of data for additional countries in the regressions of short-run changes has the effect of introducing a very large volume of trade but virtually no telephone traffic, and the coefficient relating trade to telephone message volume is thus correspondingly reduced. The regression coefficient relating short-run changes of telephone traffic to short-run changes of trade for traffic on the United States-Europe link (the coefficient b_2 of regression 5 of Table 5) is less than the corresponding coefficient relating long-run changes, although the difference is not statistically significant. The estimate of the long-run effect of changes in trade volume on the number of telephone messages is 27 additional messages per additional $1 million in trade for European traffic. The relevant figures for the short-run effect of trade are a change of 18 calls for a change of $1 million in trade with Europe. These estimates are stated in terms of 1953 prices.

Changes in trade are of considerable importance in explaining the deviations from long-term trend values of year-to-year changes in telecommunications traffic. The volume of overseas trade is quite unstable in the short run, and the large year-to-year changes in trade volume have an important effect on the year-to-year changes in telecommunications traffic. The greater importance of the trade variable in explaining the short-run changes in telecommunications traffic as compared with the long-run changes, simply reflects the fact that the absolute sum of year-to-year changes in trade volume is usually much greater than the net long-run trade change. For example, as shown in Table 6, trade between the United States and Europe increased about 20 per cent (in constant dollars) during 1951 and then declined some 15 per cent the next year. Telephone traffic to Europe increased 8 per cent during the year of trade expansion and declined 6 per cent during the year of trade recession, 1952. During 1954 the volume of trade to Europe increased 7 per cent, and during 1955 the rate of trade expansion increased to 19 per cent. Telephone traffic to Europe increased about 6 per cent during 1954 and about 19 per cent during 1955, the year of the more rapid increase in trade. This pattern has been maintained in the period of very rapid increases in telephone traffic following completion of the transatlantic telephone cables. The volume of telephone traffic to Europe increased 11 per cent during the recession year of 1958, when trade to Europe declined about 10 per cent, and increased 16 per cent during 1959, when trade increased about 18 per cent. In 1961 the volume of trade to Europe declined some 3 per cent and telephone traffic increased 14 per cent. During 1962 trade to Europe increased 10 per cent according to provisional estimates and the rate of increase of telephone traffic increased by about 21 per cent. A similar pattern of association between rates of increase of trade and telecommunications can be observed for the other links and for rates of increase of telegraph traffic.

Table 6

COMPARISON[a] OF ANNUAL INCREASES AND DECREASES OF TRADE AND TELEPHONE TRAFFIC, UNITED STATES-EUROPE, SELECTED YEARS
(in per cent)

Years	Trade	Telephone Traffic
1951	+20	+ 8
1952	-15	- 6
1954	+ 7	+ 6
1955	+19	+19
1958	-10	+11
1959	+18	+16
1961	- 3	+14
1962	+10	+21

Note:

[a] Trade percentages based on constant (1953) dollars.

The finding that a relatively large part of the short-run changes in the volume of telecommunications can be explained in terms of changes of trade underlines the importance of choosing a complete trade cycle or set of trade cycles as a reference period if projections of the future size of the telecommunications market are to be based upon extrapolations at a rate of growth characteristic of some period in the past. The volume of trade is commonly thought to be subject to a variety of cyclical influences,* and if this is so, it is important that the period on which the parameters used for extrapolation are based should be a complete period from the point of view of cyclical experience. For this reason it is doubtful that the period since the introduction of overseas telephone cable service is a satisfactory base period. Not only is there a problem in identifying that portion of traffic increase that is a response to changes in quality of service, but there is also a problem arising from the fact that a considerable portion of the increase in traffic during this period is related to the relatively large increases in trade that were associated with the recovery from the slump in overseas trade following termination of the Korean War.

The fact that there was a considerable difference between regions in the estimates of the short-run effect of trade on the volume of telecommunications during the period 1950-1961 should not be taken as implying that these differences are likely to persist at a time when there are no important interregional differences in the adequacy of telecommunications capacity relative to demand. The importance of the supply constraint cannot be evaluated precisely, but it seems significant that the size of the regression coefficients relating changes in trade to changes in telephone message volume is directly related to the quality of service. The very low estimate of the short-run trade effect on telephone traffic between the United States and Oceania is almost certainly related to the very high

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*Short cycles deriving from domestic inventory cycles and longer cycles often identified as long-swings.

average waiting time on these telephone circuits. The much higher estimate of the short-run trade effect on telephone traffic to Europe, and the small difference between estimates of the short-run and long-run relationship between trade and telephone traffic to this area, are very probably related to the fact that the average waiting time on calls to those points in Europe served by telephone cable is considerably less than the average waiting time to other overseas points. As the quality of telecommunications service to overseas points improves, the apparent magnitude of the short-run effect of trade on telephone traffic is likely to increase.

It was suggested in Section III that the strength of the relationship between changes in trade and changes in telephone message volume might be increasing over time. A given increment of trade today might call forth a larger volume of telephone traffic than the same trade increment would have 10 years ago because of such factors as changes in the telecommunications policy of firms, reduction of the real price of telephone messages, increases in the imputed money value of time as transportation times decrease, and shifts to a "higher quality" mode of telecommunications as a result of increases in income. If this is true, the appropriate basic model for regression would be

$$Y_t = aY_0e^{r_1t} + b_0e^{r_2t}X_t \tag{4.6}$$

where r_1 is the autonomous rate of growth of telecommunications traffic, b_0 is the initial value for the relationship between trade and telecommunications, and r_2 is the rate of change of that coefficient through time.

This hypothesis was tested by estimating the coefficients of the equation

$$(Y_t - Y_{t-1}) = a + b_1t + b_2(X_t - X_{t-1}) + b_3t(X_t - X_{t-1}), \tag{4.7}$$

which is a linear first approximation of the first difference form of the basic model above. However, for data on changes in total overseas trade and telephone-message volume during the period

1950-1961, the estimate of the coefficient b_3 is negative. As the standard error of estimate was several times larger than the coefficient, there appears to be no evidence on which to reject the original hypothesis that the strength of the relationship between trade and telecommunications has been constant.

APPENDIX A

CHANGES IN THE VOLUME OF TELEPHONE TRAFFIC, TELEGRAPH TRAFFIC, AND TRADE BETWEEN THE UNITED STATES AND VARIOUS OVERSEAS POINTS, FROM 1950 TO 1960

Overseas point	Changes in telephone messages (thousands)	Changes in telegraph messages (thousands)	Changes in trade (in $ millions in 1953 prices)
United Kingdom	286.78	757.0	1216.3
Germany	178.98	774.1	1252.2
France	89.98	88.5	412.1
Switzerland	37.30	181.2	181.7
Italy	61.78	382.5	550.1
Netherlands	27.88	242.4	528.8
Sweden	20.89	102.0	237.1
Belgium	9.99	- 57.9	317.5
Denmark	14.67	61.8	122.7
Norway	9.97	50.8	15.1
Spain	7.41	72.9	177.3
Portugal	1.77	10.9	12.4
Argentina	3.50	- 47.5	69.2
Brazil	8.05	-133.4	28.3
Columbia	20.00	15.0	- 76.1
Chile	5.00	21.5	128.4
Ecuador	3.07	43.5	28.0
Panama	17.87	69.4	- 44.8
Peru	10.87	63.4	171.0
Venezuela	29.45	285.2	618.2
South Africa	.83	49.8	82.5
Australia	12.22	173.4	236.0
New Zealand	2.21	57.6	93.6
Japan	23.59	281.7	1717.7
Philippines	4.29	- 13.3	85.0
Indonesia	.44	- 1.6	48.6
Israel	4.17	.7	31.9
Egypt	- .24	63.0	83.0

<u>Sources</u> (See next page.)

Sources:

Telephone and Telegraph Traffic in 1960: Federal Communications Commission, Statistics of Communications Common Carriers for 1960, Washington: Government Printing Office, 1962.

Telegraph Traffic in 1950: Federal Communications Commission, Statistics of the Communications Industry in the United States for 1950, Washington: Government Printing Office, 1952.

Telephone Traffic in 1950: W. Meckling and S. Reiger, Communications Satellites: An Introductory Survey of Technology and Economic Promise, The RAND Corporation, RM-2709-NASA, September 1960.

Trade in Current Prices: United States Department of Commerce, Statistical Abstract of the United States, 1962, Washington: Government Printing Office, 1962.

Price Indexes for Overseas Trade: United Nations, Statistical Yearbook, 1956, 1961, and 1962, New York: United Nations, 1956, 1961, 1962.

APPENDIX B

UNITED STATES-OVERSEAS TELEPHONE TRAFFIC, TELEGRAPH TRAFFIC, AND COMMODITY TRADE BY OVERSEAS REGION, 1950-1961

Region and type of traffic	Year 1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
I. Total U.S.-Overseas traffic[a]												
A. Telephone messages (x 10^5)	5.35	6.60	6.94	7.33	7.59	8.23	9.60	11.48	12.33	13.81	16.32	18.31
B. Telegraph messages (x 10^6)	16.43	17.58	17.32	17.26	17.76	18.73	19.91	20.17	19.49	20.46	20.96	21.08
C. Trade (x 10^9 in 1953 prices)	$14.59	16.83	15.69	15.17	15.44	16.97	19.66	21.13	19.24	21.24	22.24	22.54
II. U.S.-Europe												
A. Telephone messages (x 10^5)	2.81	3.04	2.86	3.09	3.28	3.91	4.84	6.48	7.18	8.32	10.58	12.07
B. Telegraph messages (x 10^6)	8.31	8.62	8.75	8.88	9.22	9.88	10.49	10.61	10.34	11.04	11.19	11.11
C. Trade (x 10^9 in 1953 prices)	$ 5.12	6.16	5.22	5.21	5.56	6.64	7.97	8.47	7.63	8.98	10.35	10.06
III. U.S.-South America and Panama												
A. Telephone messages (x 10^5)	1.18	1.34	1.40	1.42	1.48	1.62	1.80	1.94	2.02	2.15	2.21	2.30
B. Telegraph messages (x 10^6)	3.19	3.40	3.30	3.31	3.45	3.45	3.68	3.89	3.66	3.58	3.59	3.63
C. Trade (x 10^9 in 1953 prices)	$ 3.70	4.26	4.06	3.90	3.91	3.92	4.50	5.14	4.69	4.79	4.81	4.83
IV. U.S.-Australia and New Zealand												
A. Telephone messages (x 10^4)	.91	1.08	.93	.92	1.14	1.36	1.49	1.39	1.66	2.03	2.35	2.58
B. Telegraph messages (x 10^5)	2.64	3.23	2.83	2.74	3.03	3.35	3.45	3.75	3.97	4.28	4.96	5.03
C. Trade (x 10^8 in 1953 prices)	$ 3.61	6.23	5.11	3.75	4.18	4.57	4.64	4.98	4.98	7.14	7.73	7.59

Note:

[a] Excludes traffic between the United States and the following "overseas" points: Alaska, Hawaii, Puerto Rico, Cuba, Bermuda, and the Bahamas.

Sources:

Telephone and Telegraph Messages: Federal Communications Commission, Statistics of Communications Common Carriers, Washington: Government Printing Office, volumes for 1950 through 1961.

Trade: United States Department of Commerce, Statistical Abstract of the United States, Washington: Government Printing Office, volumes for 1955, 1959, and 1962.

Price Indexes: United Nations, Yearbook of International Trade Statistics, 1960, New York: United Nations, 1962.